DAMAGE TO WOODY PLANTS BY THE LOCUST LEAFMINER, *ODONTOTA DORSALIS* (COLEOPTERA: CHRYSOMELIDAE), DURING A LOCAL OUTBREAK IN AN APPALACHIAN OAK FOREST[1]

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ABSTRACT: Estimates of feeding damage to woody plants by adult locust leafminer, *Odontota dorsalis*, were made during a local outbreak in an Appalachian oak forest. Thirteen woody plant species were recorded from the outbreak area in southwestern Virginia, but only six (46.2%) sustained damage from locust leafminer feeding. Black locust received the heaviest damage. Red and chestnut oaks, sugar maple, black cherry, and hawthorn sustained moderate feeding damage. Possible causes of the outbreak are discussed.

The locust leafminer, *Odontota dorsalis* (Thunberg), is the most common insect pest of black locust (*Robinia pseudoacacia* L.) in the eastern United States. Feeding by adults and larvae of this beetle causes the extensive "scorching" of black locust leaves that is often evident in late summer.

Larvae of *O. dorsalis* are oligophagous, mining the leaves of black locust and a few other leguminous plants (Dominick 1938; Poos 1940; Wheeler 1980). Adults, however, have a broad host range and primarily feed on woody species such as apple, oak, elm, beech, dogwood and hawthorn as well as black locust (Hopkins 1896; Houser 1918; Dominick 1938; Johnson and Lyon 1976). Outbreaks of locust leafminer adults in suburban and agricultural areas can cause severe damage to shade and fruit trees (Houser 1918; Dominick 1938).

Little is known about the feeding ecology of adult locust leafminer in natural plant communities compared to the abundance of information from managed systems. A recent localized outbreak of the locust leafminer in a southern Appalachian oak forest provided an opportunity to document the feeding preferences of this insect in a diverse natural system. Here I provide a list of woody plants recorded from the outbreak area and estimates of the intensity of feeding damage to each species as well as discuss possible causes of the outbreak.

MATERIALS AND METHODS

This study was conducted on Peters Mountain, near Narrows, Giles Co., Virginia, where I first noted large numbers (up to 25 per leaf) of *O.*

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dorsalis adults feeding on leaves of northern red oak (*Quercus rubra* L.) and chestnut oak (*Q. prinus* L.) on 12 June 1988. The outbreak was confined to an area of ca. 0.25 ha, located on an exposed, northeasterly slope at an elevation of ca. 750 m.

Woody vegetation was sampled on 28 June when the browning of damaged leaf tissue facilitated estimation of feeding damage. The majority of *O. dorsalis* adults had dispersed from the outbreak area, thus total damage for the season could be estimated. Vegetation was sampled in four 30 X 2 m belt transects, each divided into a series of contiguous 5 X 2 m quadrats, centered in the outbreak area. One transect was placed parallel to the ridge on the main body of soil before a rock outcrop, and the other three were placed perpendicular to the first transect, each separated by 10 m. Woody plants were recorded by species and diameter in each transect and classified as overstory (stems $\geq$ 10 cm dbh), understory (stems $\geq$ 2.5 but < 10 cm dbh), or saplings (stems < 2.5 cm dbh). Nomenclature follows that of Radford *et al.* (1968). Voucher specimens have been deposited in the VPI & SU herbarium.

Density (number of stems per hectare), basal area (m^2 per hectare), and frequency (percent occurrence in quadrats) were determined for overstory and understory trees. To describe the relative importance of woody species in the outbreak area, importance values (relative density + relative basal area + relative frequency) were calculated for overstory and understory species (Curtis and McIntosh 1951). Importance values are presented as average percentages of the total. Importance values for saplings were calculated as average percentages of relative densities and frequencies (Adams and Stephenson 1983).

The extent of feeding damage to woody plants in the outbreak area was determined visually. All leaves on the distal 1 m of five randomly selected branches of all trees in the transects (n = 112) were scrutinized for *O. dorsalis* feeding damage [e.g., the characteristic "scraping" of upper leaf surfaces (Dominick 1938)]. In sapling and understory species, scanning of leaves was done directly at eye level, but for most overstory species binoculars were used to inspect feeding damage. Damage estimates were placed into four classes: 1) no feeding by *O. dorsalis;* 2) < 25% of leaf area damaged by *O. dorsalis;* 3) 25 to 50% of leaf area damaged by *O. dorsalis* and 4) > 50% of leaf area damaged by *O. dorsalis.* All damage estimates were made solely by the author to minimize observer bias. Broad percent damage classes were used since the precision of visual estimation of plant damage is poor at small intervals (Ruesink and Kogan 1975).

One-way analysis of variance was used to detect mean differences in feeding damage among woody plants in the study site. Individual differences in feeding damage means were determined by Duncan's multiple range test. Because there were no significant differences in damage estimates within species among forest strata, damage estimates for each species were pooled and pooled means were used for comparisons among species. Associations of woody plant importance and feeding damage estimates were examined with Pearson correlation coefficients. Data were log-transformed before analysis and all statistical tests were conducted at the $P \geq 0.05$ significance level.

RESULTS AND DISCUSSION

The composition and importance of woody plants in the outbreak area are presented in Table 1. Chestnut oak dominated the forest overstory and was also an important tree species in the understory and sapling strata. Northern red oak, black walnut (*Juglans nigra* L.), and mockernut hickory [*Carya tomentosa* (Poir.) Nutt.] occurred sparingly in the overstory. The understory stratum was dominated by redbud (*Cercis canadensis* L.), with chestnut oak, mockernut hickory and six other woody species [*Celtis laevigata* Willd. (sugarberry), *Acer saccharum* Marsh. (sugar maple), *Pinus virginiana* Mill. (Virginia pine), *Rhus typhina* L. (staghorn sumac), *Prunus serotina* Ehrh. (black cherry), *Q. rubra*] found in lesser amounts. Sugarberry, hawthorn (*Crataegus coccinea* L.) and redbud dominated the sapling stratum, whereas saplings of northern red oak, black cherry, black locust, and shagbark hickory [*Carya ovata* (Mill.) K. Koch] occurred at low levels. The ground layer in the outbreak area was not sampled quantitatively but was dominated by herbs, particularly Canada leaf-cup (*Polymnia canadensis* L.). No leafminer feeding was observed on this species.

Feeding damage estimates differed significantly among woody plants in the outbreak area ($P < 0.0001$; Table 1). The most heavily attacked species was black locust. Although black locust is the primary larval host of *O. dorsalis* in southwestern Virginia (Dominick 1938), none of the sampled trees were mined by larvae. Despite heavy feeding damage (> 50% of the leaf area destroyed) caused by adult beetles, black locust was of little importance in the outbreak area; it occurred only at low numbers as saplings. Red and chestnut oaks, sugar maple, black cherry and hawthorn sustained moderate levels of feeding damage by *O. dorsalis*. Feeding damage in these species ranged from substantial skeletonizing of leaves (ca. 50% of leaf area eaten in some oaks) to a few localized scrapes on the leaf surface (hawthorn). Among the moderately damaged species, northern red oak appeared particularly favored as leaves of this species were often heavily skeletonized. The remaining woody plants — black walnut, shagbark and mockernut hickories, redbud, sugarberry, Virginia pine and staghorn sumac — bore no evidence of feeding by *O. dorsalis*. Thus of a total of thirteen woody plants recorded from the outbreak area, only six species (46.2%) sustained damage from locust leafminer feeding.

A positive but nonsignificant association between feeding damage estimates and the importance of woody plants was observed for the outbreak area ($r = 0.76$, $P = 0.09$).

Outbreaks of locust leafminer are often described as patchy in distribution and short in duration (e.g., Dominick 1938). The patchiness of locust leafminer outbreaks has been ascribed to recruitment of adults from nearby overwintering sites (Dominick 1938) and localized reductions in black locust foliage that concentrate adults on patches of palatable plants (e.g., Houser 1918). Unfortunately, I can only speculate on the origin of the outbreak on Peters Mountain. Although conditions favorable for overwintering of locust leafminer adults [e.g., a dense shrub layer and heavy litter accumulation (Dominick 1938)] occurred in the outbreak area, these conditions were also common in the surrounding forest. Moreover, emergence of overwintered *O. dorsalis* adults in southwestern Virginia begins in early May and is completed before mid-June (Dominick 1938 and pers. obs.); therefore, it seems unlikely that the outbreak was the result of the emergence of adults from patchy overwintering habitat.

It is also unlikely that the abundance of black locust influenced the patchy nature of the outbreak. First, black locust comprises a small proportion of the forest vegetation on Peters Mountain (Adams and Stephenson 1983) and second, the composition of vegetation in the outbreak area, particularly the species attacked by *O. dorsalis,* did not differ from the composition of the surrounding forest matrix; thus patchwise colonization of woody plants is improbable. Recent evidence suggests that stress, particularly drought stress, may predispose plant populations to insect herbivore outbreaks (Mattson and Haack 1987). Given the dry, exposed, ridgetop location of the outbreak area, it seems feasible that the eruption of *O. dorsalis* may have been mediated by plant stress. Moreover, the dry summer of 1988 may have accentuated the droughty nature of the shallow soils in the outbreak area. Drought-stressed plants differ physically (e.g., greater infrared reflectance, leaf yellowing) and chemically (e.g., increased levels of soluble nitrogen and sugars in tissues) from non-stressed plants and so may be more attractive or acceptable to insects (Mattson and Haack 1987). Thus drought-stressed trees associated with exposed ridgetop soils, may partially explain the localized nature of the locust leafminer outbreak on Peters Mountain. Culbertson (1915) also surmised that drought was a factor in large-scale eruptions of the locust leafminer in southern Indiana.

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Table 1. Importance values and mean feeding damage estimates to woody plants caused by the locust leafminer, Peters Mountain, Virginia, 1988. Means of feeding damage classes for each tree species represent pooled estimates for overstory, understory, and sapling strata [Damage classes include: 1) no feeding by *O. dorsalis;* 2) < 25% of leaf area damaged by *O. dorsalis;* 3) 25 to 50% of leaf area damaged by *O. dorsalis* and 4) > 50% of leaf area damaged by *O. dorsalis*]. Means followed by the same letter do not differ significantly (Duncan's multiple range test, $P < 0.05$).

	$\overline{X}$ Percent Importance Value			
Species	Overstory	Understory	Saplings	$\overline{X}$ Damage Class
Quercus prinus	87.2	12.7	11.3	2.36bc
Q. rubra	6.7	2.9	7.5	2.57b
Juglans nigra	4.7	—	—	1.00d
Carya ovata	—	—	2.2	1.00d
C. tomentosa	1.4	11.9	—	1.00d
Cercis canadensis	—	51.3	17.9	1.00d
Celtis laevigata	—	7.5	27.4	1.00d
Acer saccharum	—	4.2	—	2.00bc
Pinus virginiana	—	3.6	—	1.00d
Rhus typhina	—	3.0	—	1.00d
Prunus serotina	—	2.8	7.7	2.00bc
Crataegus coccinea	—	—	21.5	1.94c
Robinia pseudoacacia	—	—	4.5	3.50a

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